Directions for Spraying Fruits in Illinois

By Department of Horticulture and Illinois State Natural History Survey

Circular 429

University of Illinois: College of Agriculture, Agricultural Experiment Station and Extension Service

In cooperation with the Illinois State Natural History Survey

CONTENTS

Insects to be identified should be sent in boxes or cotton-stopped bottles to the Chief Entomologist, Illinois State Natural History Survey, Urbana. Specimens of fungous diseases should be sent to the Department of Horticulture, Illinois Agricultural Experiment Station, Urbana.

Urbana, Illinois

March, 1935

Printed in furtherance of the Agricultural Extension Act approved by Congress May 8, 1914. H. W. MUMFORD, *Director*, Agricultural Extension Service, University of Illinois.

MANUFACTURERS OF INSECTICIDES AND FUNGICIDES[1]

General[2]

Ansbacher-Siegel Corp.
50 Union Square
New York, N. Y.

Bowker Chemical Co.
420 Lexington Ave.
New York, N. Y.

Corona Chemical Co.
Milwaukee, Wis.

Devoe & Reynolds Co.
Chicago, Ill.

Dow Chemical Co.
Midland, Mich.

General Chemical Co.
818 Olive St.
St. Louis, Mo.

Grasselli Chemical Co.
Cleveland, Ohio

Latimer-Goodwin Chemical Co.
Grand Junction, Colorado

John Lucas & Co.
Chicago, Ill.

Martin Senour Co.
Chicago, Ill.

J. A. McCarty Seed Co.
526 N.W. 4th St.
Evansville, Ind.

Niagara Sprayer & Chemical Co., Inc.
Middleport, N. Y.

G. S. Robins Co.
310 S. Commercial St.
St. Louis, Mo.

Sherwin-Williams Co.
101 Prospect Ave., N. W.
Cleveland, Ohio, and
115th St. & Cottage Grove Ave.
Chicago, Ill.

Tobacco Products

Tobacco By-Products & Chemical Corp.
Louisville, Ky.

Oil Sprays and Soaps

California Spray-Chemical Corp.
P. O. Box 25
National Stock Yards, Ill.

Crystal Soap & Chemical Co., Inc.
State Rd. and Robbins Ave.
Tacony, Philadelphia, Pa.

Good-Wil Lubricating Oil Co.
Brown and Geraldine Aves.
St. Louis, Mo.

B. G. Pratt Co.
50 Church St.
New York, N. Y., and
Indianapolis, Ind.
(Western distributor—H. J. Weber & Sons, Affton, Mo.)

Schaeffer Bros. & Powell Mfg. Co.
102 Barton St.
St. Louis, Mo.

Sun Oil Co.
33 N. High St.
Columbus, Ohio, and
Philadelphia, Pa.

Standard Oil Co. of Indiana
910 S. Michigan Ave.
Chicago, Ill.

Sulfur

Southern Acid & Sulfur Co., Inc.
Rialto Bldg.
St. Louis, Mo.

Stauffer Chemical Co.
Carbide and Carbon Bldg.
Chicago, Ill.

Flotation Sulfur

Koppers Products Co.
Koppers Bldg.
Pittsburgh, Pa.

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[1]This list does not pretend to be complete, for there are many other firms handling this class of materials. Products are in no way guaranteed by the inclusion of the name of the manufacturer in this list.

[2]These firms handle most of the insecticides and fungicides, including miscible oils, soaps, casein-lime, paradichlorobenzene, wettable sulfurs, dusts, materials for band treating, etc. Oils for making lubricating oil emulsion can be obtained from any of the larger oil companies; insist on oils of the proper specifications.

5000—5-35—7688-S

Lime

Lehigh Lime Co.
111 W. Washington St.
Chicago, Ill.

Hunkins-Willis Lime Co.
11th and Locust Sts.
St. Louis, Mo.

Marblehead Lime Co.
160 N. La Salle St.
Chicago, Ill.

Casein-Lime

Casein Mfg. Co. of America, Inc.
205 E. 42nd St.
New York, N. Y.

Goulac (Lignin Pitch)

Amer. Gum Products Co.
N. Y. Central Bldg.
230 Park Ave.
New York, N. Y.

MANUFACTURERS OF SPRAYING AND DUSTING MACHINERY

Sprayers and Accessories

John Bean Mfg. Co.
Lansing, Mich.

E. C. Brown Co.
Rochester, N. Y.

The Deming Company
Salem, Ohio
(Distributor—The Grinnell Company, 4425 Southwestern Ave. Chicago, Ill.)

Field Force Pump Co.
Elmira, N. Y.

Friend Mfg. Co.
Gasport, N. Y.

Hardie Mfg. Co.
Hudson, Mich.

H. D. Hudson
589 N. Ill. St.
N. Pier Term.
Chicago, Ill.

F. E. Myers & Bro. Co.
Orange St.
Ashland, Ohio

William Stahl Sprayer Co.
Quincy, Ill.

Dusting Machinery

John Bean Mfg. Co.
Lansing, Mich.

Feeny Mfg. Co.
Muncie, Ind.

Messinger Mfg. Co.
Tatamy, Pa.

Niagara Sprayer and Chemical Co., Inc.
Middleport, N. Y.

Peerless Dust Gun Co.
5100 St. Clair Ave.
Cleveland, Ohio

The Root Manufacturing Company
1051 Power Ave.
Cleveland, Ohio

MANUFACTURERS OF BANDING MATERIALS

Corrugated Paper

Pomeroy Mfg. Co.
Vincennes, Ind.

Hinde & Dauch Paper Co.
5110 Penrose St.
St. Louis, Mo.

Graham Paper Co.
1014-1030 Spruce St.
St. Louis, Mo.

Treated Bands

Amer. Cyanamid Chem. Corp.
30 Rockefeller Plaza
New York, N. Y.

W-B Chemical Co.
500 Fifth Avenue
New York, N. Y.

J. A. McCarty Seed Co.
526 N.W. 4th St.
Evansville, Ind.

Edwin C. Tyson
Flora Dale, Pa.

Beta Naphthol

Calco Chemical Co., Inc.
Bound Brook, N. J.

The Ciba Co.
325 W. Huron St.
Chicago, Ill.

There are many reliable local dealers in spray materials from whom standard insecticides and fungicides may be obtained.

This list supplements Circular No. 388, Illinois Agricultural Experiment Station, "Directions for Spraying Fruits in Illinois."

Directions for Spraying Fruits in Illinois

Prepared by the Department of Horticulture and the Illinois State Natural History Survey[1]

PART I—SOME GENERAL FACTS ABOUT INSECTS, DISEASES, AND SPRAYING

SPRAYING is the most effective way of controlling insects and fungous diseases attacking fruits in Illinois. In order that spraying may be done intelligently and satisfactorily, the orchardist should have a practical knowledge of the insects and diseases which affect his crop.

Two classes of insect pests. Fruit insects may be divided into two classes: sucking insects and chewing insects. The *sucking insects,* such as San Jose scale and aphids (commonly known as plant lice), extract their food from the sap of plants. These are combated by contact sprays which must strike the insects themselves. Lime sulfur, liquid or dry, oil emulsion, summer oils, and miscible oils are used against scale insects. Nicotine sulfate, oil emulsion, and miscible oils are used against aphids. The *chewing insects,* such as the codling moth, plum curculio, and cankerworm, actually eat the fruit or foliage. These are destroyed by poisoning their food. Lead arsenate is the standard material used against chewing insects.[2]

Certain pests, such as the leaf roller, European red mite and other mites, can best be controlled by sprays applied to their eggs, which are laid on the twigs, branches, and trunks. Some contact poisons are also effective against chewing insects.

Fungous diseases common. Examples of fungous diseases of Illinois fruits are brown rot of stone fruits, apple scab, apple blotch, and black rot of grapes. Fungi are in reality plants living on the fruit, leaves, stems, or roots of other plants. Infection spreads by spores, which, when wet for a sufficient time, germinate and enter the surface.

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[1]A revision of Circular 388, by W. P. Flint, Chief Entomologist, Illinois State Natural History Survey, and Entomologist, Agricultural Experiment Station, and H. W. Anderson, Chief in Pomological Pathology, Agricultural Experiment Station.

[2]At the date of printing the federal government has established a *spray residue tolerance* of **.01** grain of arsenic trioxid (As_2O_3), **.018** grain of lead (Pb), **.21** grain of copper (Cu), and **.01** grain of fluorine (F) per pound of fruit. Fruit of any kind showing residues in excess of the above amounts of any of these materials is liable to seizure by federal authorities if transported interstate or offered for foreign export. Certain states and municipalities have imposed tolerance regulations of their own.

The injuries characteristic of the disease are then produced. In order to control the disease, sprays must cover the susceptible parts of the plants thruout the period of infection. Usually after the spores have germinated and the fungus has invaded the tissues, spraying will not control the disease. *A comprehensive description of the diseases of Illinois fruits is given in Circular 241 of this Station, "Diseases of Illinois Fruits," which will be sent on request.*

Lime sulfur and bordeaux are standard materials used to control fungous diseases in this state. Because of their convenience, dry-mix sulfur lime and the commercial wettable sulfurs have largely replaced self-boiled lime and sulfur. For spraying small orchards or fruit gardens commercial lime sulfur, either liquid or dry, is more convenient than homemade lime sulfur and saves time.

Care will reduce spray injury. While the spray mixtures recommended in this schedule are designed to give maximum protection with minimum injury, there is no assurance that they will be safe under all conditions. So many factors—*climatic conditions; fruit varieties; vigor of trees; time, method, and amount of spray applications*—are involved in spray injury that it is impossible to give specific rules for avoiding it. The following general observations, however, may be of value:

Trees in a *vigorous condition* are less susceptible to spray injury than are those lacking in vigor.

Lime sulfur when used following heavy scab infection has been found to cause severe injury and may cause stunting of the leaves at any time due to marginal injury or may cause yellowing and dropping in some varieties such as Jonathan or Wealthy. Lime sulfur should not be applied during hot, dry weather.

Sprays containing *oil* will cause serious foliage injury if applied when sulfur is present on the leaves. For this reason, neither oil alone nor oil and lead arsenate should be used until at least ten days after the last sulfur spray, and a longer period will be necessary when dry weather prevails after the application of sulfur.

Bordeaux mixture should be used only when apples are past the "fuzzy" stage (except in the case of full bloom sprays on blight-susceptible varieties). If it is necessary to use bordeaux in the early part of the season when the apples are young, it should be applied during a dry period. When used later, bordeaux should not be applied if the soil is decidedly deficient in water, that is, during drouth periods.

Lead arsenate is likely to cause injury in weather when the trees remain moist over a long period.

Some fruit varieties need much more protection than others, and

the grower must learn by observation how much spraying is necessary and how to avoid excessive spray injury.

Thoro spraying highly important. Thoroness in spraying is as important as is the use of the right materials at exactly the right time. It is of much more importance than any factor such as pressure or size of nozzle openings. No very definite estimate of the amount of spray necessary can be given, since it varies with many factors, including the kind, size, density, and variety of the tree or bush and the pests to be controlled. The efficiency of the apparatus in spraying without undue loss of material is also an important factor. The pump and nozzle should be large enough to avoid wasting the time of the operator and small enough to avoid wasting material. A beginner may roughly estimate the number of gallons required for one application to a mature apple tree by dividing the age of the tree in years by 1.5.

The formulas in the following schedules are based on the preparation of 100 gallons of spray at one time. The proportions, of course, remain the same regardless of quantity.

PART II—SPRAY SCHEDULES

Associated with the climatic variations that occur in different sections of Illinois are found differences in the severity of certain fungous diseases and insect infestations. Certain insects or fungous diseases that may be absent in one section may be found in another. Climatic variations in different seasons also modify the severity of the attack and the ease of control of the various pests. All these factors affect the spraying program, especially that for apples.

PLANNING SPRAY SCHEDULE FOR APPLES

The spraying program for apples should be laid out with specific reference to the orchard to be protected, its locality, the varieties grown, the age and condition of the trees and their immediate surroundings. A spray that combines an insecticide with a fungicide can usually be applied, thus controlling insect pests and fungous diseases with the same application.

The insects upon the control of which an apple spray schedule is based are *codling moth, San Jose scale,*[1] *plum curculio, scurfy scale, oyster shell scale,* and *aphids;* the fungi are *apple scab, apple blotch,*

[1]For further information on scale control see Ill. State Nat. Hist. Surv. Bul., Art. II, Vol. 16, entitled "Recent Insecticide Experiments in Illinois With Lubricating Oil Emulsions."

and *bitter rot*. Other insects, such as the canker worms and various leaf feeders, and other fungi, such as sooty blotch, are controlled incidentally.

Location of orchard in state. The distribution of most apple insects and fungi and the severity of their attack vary primarily with the latitude (Fig. 1).

San Jose scale is relatively unimportant in the northern quarter of the state, where *oyster shell scale* is sometimes a limiting factor in apple production and where *scurfy scale* is often abundant. In the remainder of the state this condition is reversed, the oyster shell scale and scurfy scale doing little damage, while the San Jose scale is often very destructive in the southern half. The *green aphis* and the *rosy aphis* are distributed thruout the state,[1] and the injury produced by the *plum curculio* is not greatly modified as yet by latitude.

Codling moth is important thruout the state, but is especially troublesome in the southern section, owing to the greater number of broods that occur there. In the extreme northern part of Illinois there is one full brood, and a partial second brood. In southern Illinois there is one full brood, almost a full second, and a partial third brood. Thus late infestations are much more serious in southern Illinois than in northern.

The *Oriental fruit* moth was found in southern Illinois in 1927 and has now spread to all peach-growing sections of the state. It has been found attacking apples where interplanted with peaches or where located near peach orchards.

Among the fungi, *scab* is a serious disease over the entire state; *blotch* is confined, roughly, to the southern half; and *bitter rot*, roughly, to the southern third. Scab is to be considered, therefore, in planning a spray schedule for any part of the state; scab and blotch, in planning one for the southern half; and scab, blotch, and bitter rot in planning one for the southern third.

Variety to be treated. Varieties of apples differ greatly in their degree of susceptibility to fungi. Immunity to one fungus, however, does not imply immunity to another; one variety may be very resistant to scab and susceptible to blotch, and another may be resistant to blotch and susceptible to scab. The spraying program can often be adjusted to advantage to meet these differences. For example, Delicious, which

[1]The severity of attacks by aphids varies greatly from season to season. See page 9, tar oils under "Dormant spray," and page 22, "Nicotine sulfate," for control methods.

Northern

Oyster shell and *scurfy scales* prevalent. *San Jose scale* light. *Codling moth,* one brood and partial second.

North Central

San Jose scale moderately abundant. *Codling moth,* one brood and partial second. Occasional *blotch* infection. *Oriental fruit moth.*

South Central

Bitter rot, blotch moderating toward northern boundary. *San Jose scale* serious. *Codling moth,* heavy second and partial third brood. *Oriental fruit moth.*

Southern

Blotch, bitter rot, and *San Jose scale* serious. *Codling moth,* heavy second and third broods. *Oriental fruit moth.*

Entire State

Scab, curculio, and codling moth must be sprayed for in all sections of the state.

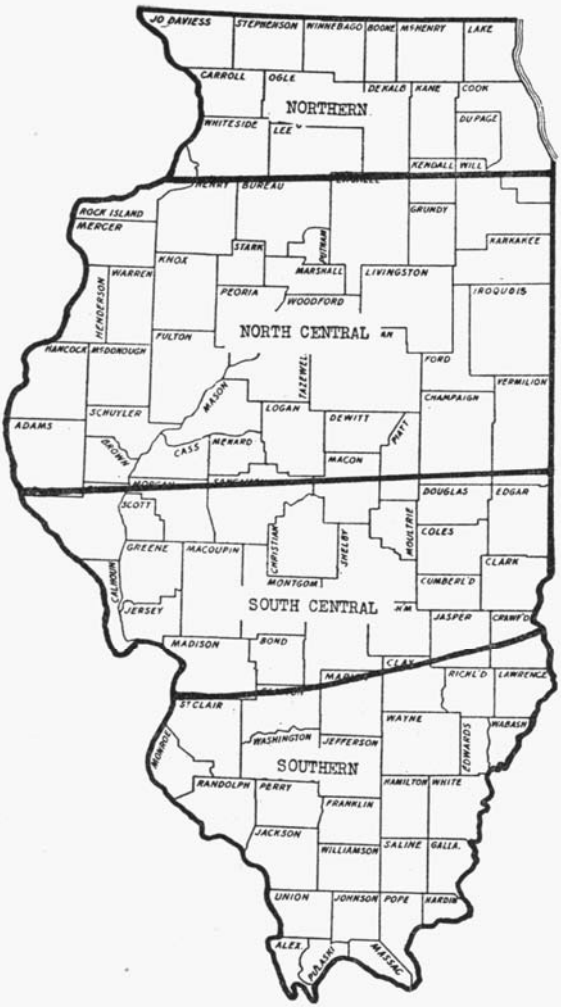

Fig. 1.—General distribution and severity of insects and fungi which modify the spray schedule in different parts of Illinois

is very susceptible to apple scab and very resistant to blotch, should receive all sprays important in the control of scab, but need not be given the sprays designed primarily for blotch.

While varieties differ somewhat in susceptibility to insect injury, these differences usually are not great enough to warrant changes in the spray schedule. However, those varieties listed in Table 1 as susceptible or very susceptible to San Jose scale should be given especial attention.

TABLE 1.—VARIETAL RESISTANCE AND SUSCEPTIBILITY OF APPLES TO SCAB, BLOTCH, BITTER ROT, AND SAN JOSE SCALE
(R = resistant; S = susceptible; V = very)

Variety	Scab	Blotch[1]	Bitter rot[1]	San Jose scale
Akin	R	R	R	—
Ben Davis	VS	S	VS	S
Benoni	R	VS	(2)	—
Collins (Champion)	R	R	R	—
Delicious	VS	VR	—	S
Duchess (Oldenburg)	VR	VS	(2)	S
Early Harvest	VS	VS	—	R
Fameuse (Snow)	VS	(3)	—	S
Golden Delicious	S	—	S	S
Grimes	R	R	VS	VS
Huntsman	R	VS	S	S
Jonathan	VR[4]	R	VS	R
King David	R	R	VS	—
Kinnaird	VS	VR	R	S
McIntosh	VS	VS	(5)	—
Maiden Blush	S	VS	R	S
Minkler	R	R	R	R
Missouri Pippin	R	VS	—	VS
Northwestern Greening	S	VS	(5)	VS
Red June	VS	R	(2)	S
Rome Beauty	VS	S	R	VR
Salome	R	S	—	—
Stark	—	VS	—	—
Stayman	R	VR	R	R
Turley	S	R	—	—
Wealthy	VR	VR	—	S
Willowtwig	S	S	VS	R
Winesap	S	VR	R	S
Yellow Transparent	R	R	(2)	S
York Imperial	R	R	R	S

[1]The data on varietal resistance to blotch and bitter rot, presented in this table, hold for the localities where these fungi are most prevalent. The varieties most susceptible to these fungi are subject to infection for some distance north of these regions. [2]Ripens early and thus ordinarily escapes infection. [3]Not grown in blotch area. [4]Leaves susceptible. [5]Not grown in bitter-rot area.

Age and condition of trees and immediate surroundings. All apple trees in the southern and south-central sections of the state should receive yearly dormant spraying for San Jose scale.

In the southern and south-central sections all young trees of varieties susceptible to blotch should receive applications of bordeaux 2 and 4 weeks after petal fall to reduce twig infections. Lead arsenate should be added (at the usual rate) to the bordeaux applied to control leaf-eating insects.

Fungus and insect control on trees of bearing age is facilitated by proper pruning. Altho this is a secondary object of pruning, it is often

an important one. A tree should not be allowed to grow too high or become too dense.

Proximity to scale-infested orchards makes scale control very difficult; proximity to uncultivated fields and woodlands increases the likelihood of injury by curculio.

Season. Wet weather promotes fungous infection, and rain or humid weather during periods when infections are likely to occur increases the severity of fungous attacks. As a rule dry warm weather is favorable to insects.

APPLE SCHEDULE

Where this schedule is followed, the apples at picking time will probably carry more than the legal spray residue and should be washed before marketing (see footnote 2, page 3).

Dormant spray. This spray is used particularly for the control of *San Jose scale* and should be applied annually as a matter of precaution in all apple orchards in the state. Apply any time during the dormant period of the tree when the temperature is high enough so that the spray will dry before freezing.

Two groups of materials are recommended for the dormant, or scale, spray: certain lubricating oil emulsions and miscible oils, and strong lime sulfur solutions. Oil sprays are more effective than lime sulfur in killing San Jose scale. *Each 100 gallons of dormant spray should contain—*

3 gallons lubricating oil emulsion (page 18)
—or commercial miscible oils at concentrations recommended by manufacturers
—or 12 gallons commercial concentrated lime sulfur testing 33° Baumé (equivalent to a specific gravity of 1.2946)
—or 30 to 56 pounds dry lime sulfur (30 pounds for points north of Hancock and Vermilion counties, 56 pounds for Hancock and Vermilion counties and points in same latitude or south)

If an orchard is infested with *green* or *rosy aphis,* almost complete control can be obtained by a dormant spray of one of the commercial miscible tar oils at concentrations recommended by the manufacturer. These tar oils cannot be depended upon to control severe infestations of San Jose scale.

When applied in the delayed dormant or tip green stage of the apple, most oil emulsions or miscible oils will kill the aphids wet by them. Nicotine sulfate 1-2000 greatly increases the efficiency of these sprays.

Cluster-bud spray. This is primarily for the control of *apple scab* but is also used to control *cankerworm* and *bud moth.* It should be begun when the flower buds first show pink and completed before any of them have opened. *Each 100 gallons of spray should contain—*

2 gallons commercial lime sulfur testing 33° Baumé
—or 6 pounds of dry lime sulfur
—or 8 pounds flotation sulfur (page 24)

If cankerworm or bud moth is present, add 2 pounds powdered lead arsenate and 2 pounds hydrated lime.

Full bloom spray. If cold, damp weather prevails following the pre-bloom, thus extending the blooming period, an *extra scab spray* should be applied during the bloom consisting of 5 pounds flotation sulfur in 100 gallons of water or a 2-6-100 bordeaux mixture on varieties susceptible to blossom blight. *No lead arsenate should be added* to the spray.

Calyx spray. *This spray is for the control of codling moth but is equally important as a spray for scab.* It is also valuable as a spray against *bud moth, green fruit worm,* and *plum curculio.* Start applying when three-fourths of the petals have fallen, and complete before the calyx lobes close on the most advanced fruit, which usually will be within 5 days or less. *Use same materials as for the cluster-bud spray* but add 3 pounds lead arsenate and 3 pounds hydrated lime.

On varieties only moderately susceptible to scab, 5 instead of 8 pounds of flotation sulfur may be used.

First cover spray. Apply one week after petal fall. This application is particularly for *curculio* and *apple scab* control and to build up a protective covering where *codling moth* is abundant. Add 4 pounds lead arsenate and 4 pounds hydrated lime to the fungicide used in the calyx spray. This application is also sometimes made for blotch. Flotation sulfur may be reduced to 5 pounds on varieties moderately susceptible to scab but should be maintained at 8 to 10 pounds on blotch susceptible varieties or where scab conditions are especially serious.

Second cover spray. Apply 15 to 20 days after petal fall. **A special notice on orchard insect and disease conditions is sent out about this time to all those applying for this service.** This spray is applied for *blotch, scab, leaf spot, first-brood codling moth,* and *curculio.* For each 100 gallons of spray use—

2 gallons commercial lime sulfur
—or 4 pounds dry lime sulfur
—or 5 pounds flotation sulfur
and 3 or 4 pounds lead arsenate and 3 or 4 pounds hydrated lime.

On blotch susceptible varieties or when oil in combination with lead arsenate[1] is used in this application, use bordeaux standard strength (4-6-100) in place of the sulfur-containing sprays listed above (see page 4 under "Care will reduce spray injury.")

Third cover spray. Apply 10 days after the second cover spray. Use 4 pounds lead arsenate, 4 pounds hydrated lime, and 3 quarts summer oil emulsion,[1] to 100 gallons of spray material. On blotch-susceptible varieties, use bordeaux 4-6-100.

Fourth cover spray. Apply 10 days after third cover spray. This application is for *blotch* and *codling moth.* Use bordeaux 4-6-100 to which has been added 3 pounds lead arsenate. When codling moth infestation is

[1]The amount of summer oil emulsion used should be based on the actual oil content of the emulsion. Three quarts of summer oil emulsion, as listed in the sprays in this circular, should contain 2 quarts of actual oil, the amount recommended in 100 gallons of spray material. Oil should not be used without bordeaux unless rainy weather has removed the sulfur of the calyx and cover sprays.

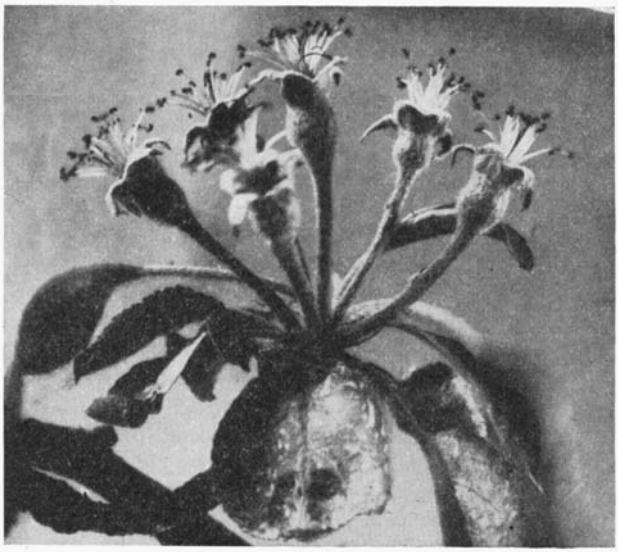

Fig. 2.—Proper condition and time for the calyx spray of the apple
Note that the calyx lobes are still open and that the petals have fallen.

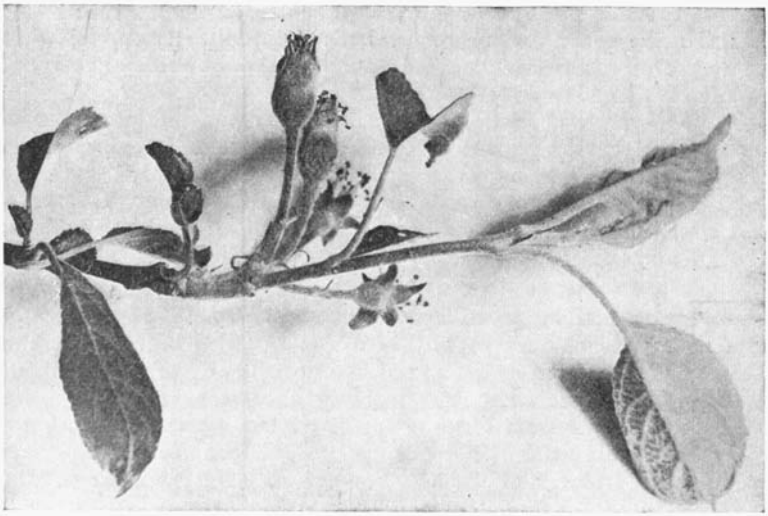

Fig. 3.—Too late for calyx spray
The calyxes of the apples which have set are closed.

very abundant, add 3 quarts summer oil emulsion. If blotch is not present, use 3 pounds hydrated lime with the lead arsenate in place of bordeaux.

Special first-brood sprays. For heavily infested blocks, close the interval between the second, third, and fourth sprays to 7 days and add a fifth spray using the same materials as in the fourth.

Special sprays for summer apples such as Transparent. Use the calyx spray given above and follow by at least 3 or 4 sprays containing 3 quarts of summer oil emulsion and 40-percent nicotine sulfate 1-800. The first of these sprays should be applied 15 to 20 days after the calyx spray and the others at weekly to 10-day intervals up to picking time. On Benoni and Duchess use bordeaux 4-6-100 plus 40-percent nicotine sulfate 1-800.

Note. *The time of appearance of the second and third broods of codling moth varies with locality and season. The Experiment Station and the Natural History Survey make annual observations as to time to spray for each brood. Advice is mailed to about 3,000 orchardists. This information will be sent to any fruit grower on request. Timeliness is very important.*

First second-brood spray. In each 100 gallons of spray use 3 pounds lead arsenate, 3 pounds hydrated lime, and 3 quarts summer oil emulsion.

Second second-brood spray. Apply 9 to 12 days after the first second-brood spray, using the same materials.

Third second-brood spray. Apply 12 days after the second second-brood spray. Use 3 pounds lead arsenate and 6 pounds hydrated lime in each 100 gallons of spray. In many orchards it will be necessary to use oil in the third second-brood spray and also in one or two later sprays. This will make spray residue removal more difficult. By special washing in heated solutions, residue may be reduced below the tolerance even tho oil sprays are applied as late as August 15.

Fruit sprayed with lead arsenate will require washing in most cases in order to meet the spray residue requirements. Where it is impossible to wash the fruit, a 1-percent summer oil plus nicotine 1-1200, or in severe infestations, 1-800, should be used in all second-brood sprays. Even with this combination sufficient lead residue may remain from the first-brood sprays to put the fruit over the present lead tolerance. This spray is likely to cause some spotting of Grimes.

Late-brood codling moth and bitter rot sprays. The second-brood infestation increases very rapidly in dry years with high temperatures. Continuation of second-brood sprays at intervals of two weeks up to the first of September or even later is often necessary in heavily infested orchards. If it is necessary to spray during the latter part of August or first of September for codling moth control, use 2 pounds lead arsenate, 4 pounds hydrated lime, and 3 quarts summer oil emulsion in each 100 gallons of spray.

Special bitter rot sprays. Where this disease is anticipated, start spraying the first week in July, and repeat at intervals of 10 days until four applications have been made. Bordeaux (page 19) is the proper fungicide to use. If no preventive sprays have been applied and the disease appears unexpectedly, start spraying immediately.

PEAR SCHEDULE

Dormant spray. On bearing Kieffer or Garber pears this spray is necessary only when the trees have become moderately infested. Most other varieties of pears grown in the southern section will require annual spraying, the same as apples, as a precautionary measure.

A serious pest of pears known as the *pear psylla* appeared for the first time in Illinois in 1929. In areas where this insect is causing damage, pears should receive a thoro dormant spray with homemade oil emulsion, or one of the miscible oils, used at the highest strength recommended for the control of San Jose scale on apple.

Calyx spray. This is for *codling moth, curculio, leaf spots,* and *pear scab.* Start applying as soon as the petals have fallen. In each 100 gallons of spray use 3 pounds lead arsenate and 2 gallons commercial lime sulfur.

First cover spray. Apply 18 to 21 days after petal fall. This is for *codling moth, curculio, leaf spots,* and *sooty blotch.* Use same materials in the same proportion as for the calyx spray.

Additional sprays. If codling moth is abundant, apply sprays to pears at the same time, using the same materials as in first second-brood spray for apples. If leaf spot is prevalent, bordeaux 6-8-100 should be applied at intervals of 2 weeks until about August 1.

PEACHES[1]

Dormant spray. This is used against *San Jose scale* and *leaf curl.* Apply in the fall after the leaves have dropped or in the spring before the buds swell. *In each 100 gallons of spray use—*

12½ gallons commercial liquid lime sulfur
—or not less than 30 pounds dry lime sulfur
—or 3 gallons boiled lubricating oil emulsion (4½ gallons where scale is very abundant) plus bordeaux 8-8-100
—or commercial miscible oil with fungicide as recommended by manufacturer

If scale is not present, leaf curl may be controlled with 6¼ gallons of lime sulfur, or an 8-8-100 bordeaux mixture with or without oil emulsion.

First summer spray. This treatment, which is for *plum curculio,* should be begun about 10 days following bloom, when the shucks are half

[1]The most destructive insect attacking the peach is the peach borer. This insect cannot be controlled by spraying but is easily killed by the application of paradichlorobenzene about the base of the trunk from September 25 to October 20. This chemical should be used at the rate of ½ to 1½ ounces per tree, depending upon the age of the tree. It should be applied at not more than 3 inches from the trunk, but care must be taken that none of it touches the bark. It should be covered with about 2 inches of soil. This material should not be applied during the season the trees are planted. For full directions for the control of the peach borer, see Illinois State Natural History Survey, Entomology Circular 26, "The Insect Enemies of the Peach in Illinois." Address Illinois State Natural History Survey, Urbana, Illinois.

The Oriental fruit moth, a serious pest of peaches and other fruits, is now established in Illinois. No satisfactory spray has yet been found for the control of this insect. Supplementary directions for controlling this insect will be sent to anyone requesting them.

off the young fruit. In each 100 gallons of spray use 3 pounds powdered lead arsenate, with zinc sulfate and lime in the proportions given on page 21. Zinc sulfate and lime (zinc bordeaux) has been found to reduce greatly lead arsenate injury and is recommended for this purpose.

Many commercial growers have found it an advantage to repeat this application as soon as the first spraying has been completed.

Do not use dry lime sulfur or liquid lime sulfur as summer sprays for peaches.

Second summer spray. About 10 days after the first summer spray, apply a spray for *plum curculio, bacterial spot,* and *scab.* Use same materials in same proportions as in first summer spray. On scab-susceptible varieties[1] 6 pounds flotation sulfur or commercial wettable sulfur should be added.

Third summer spray. About 2 to 3 weeks later apply another spray, using same materials as used in second summer spray.

Fourth summer spray. Apply one month before harvest for control of late *curculio.* Use 2 pounds lead arsenate with zinc sulfate and lime in the proportions given on page 21.

A special notice on peach insect conditions sent out to all applying will state whether this spray or other sprays are necessary. Tests indicate that some control of the *Oriental fruit moth* is secured by the use of sprays intended for curculio and brown rot.

Fifth summer spray. Three weeks before harvest, apply a spray for *brown rot.* Use flotation or other wettable sulfurs, 6 pounds sulfur to 100 gallons of spray. *Do not add lead or lime.*

Sixth summer spray. One week before harvest apply another *brown rot* spray, using same materials in same proportion as in preceding spray.

Dusting. Oil dusts are the most effective insecticides to use for the control of the Oriental fruit moth, and are also recommended for the control of curculio. Formulas and directions for mixing are given on page 23.

SOUR CHERRIES

Dormant spray. Sour cherries are frequently infested with *Forbes' scale* and occasionally with *San Jose scale.* For these apply a dormant spray of lime sulfur or dormant oil the same as for the apple.

First summer spray. This is for *brown rot, leaf spot, curculio,* and *slug.* Spray immediately after the shucks have fallen. *In each 100 gallons of spray use—*

2 gallons commercial lime sulfur
—or 10 pounds flotation sulfur (dry basis)
and 3 pounds lead arsenate and 6 pounds hydrated lime.

Second summer spray. When damp weather follows the first summer spray, make another application 10 days later, using same materials.

[1]Peach varieties ripening later than Elberta are generally more susceptible to scab than those ripening with or earlier than Elberta. Under climatic conditions favorable to the development of the disease or in low areas, Elberta and similar varieties may be severely scabbed, but, as a rule, lead arsenate with zinc sulfate and lime will keep the disease under control.

Additional sprays. If *leaf spot* (yellow leaf) is prevalent, apply a spray of bordeaux mixture 4-6-100 or flotation sulfur 10-100 immediately after harvest.

If *cherry slugs* appear in abundance in August, apply a spray of 2 pounds powdered lead arsenate and 6 pounds hydrated lime to 100 gallons of spray.

PLUMS

Dormant spray. Same as for apples.

First summer spray. Make this application, which is for the control of *leaf diseases, brown rot,* and *plum curculio,* just before the blossom buds open. Use lime sulfur and lead arsenate as for the first summer spray for cherries.

Second summer spray. This also is for *leaf diseases, brown rot,* and *curculio.* Apply immediately after the shucks fall. Use lime sulfur and lead arsenate as for the first summer spray. For Japanese varieties use flotation or commercial wettable sulfurs in place of lime sulfur.

Third summer spray. This again is for *leaf diseases, brown rot,* and *plum curculio.* About 10 days after the second summer application apply same materials as directed for previous sprays.

Additional spray. If the season is exceptionally wet, or if *curculio* is a serious pest, spray at intervals of 2 weeks until 4 weeks before picking time, with same materials and at same strength as for the second summer spray. One to 2 weeks before harvest, apply an additional spray of wettable sulfur 8 pounds to 100 gallons *without lead arsenate* for the control of brown rot. Sulfur dusts (see Oil Dusts, page 23) may be substituted for these sprays, but should be applied at weekly intervals.

Aphids occasionally become very abundant on plums. Spray with a 40-percent nicotine sulfate solution (1 pint to 100 gallons of water in which 4 pounds of soap have been dissolved).

Black knot may be controlled by removing and burning all twigs showing the knots during the winter months. On large limbs the knots may be cut out, thus saving the limbs. A delayed dormant spray of 12½ gallons lime sulfur to 100 gallons of spray should be applied in addition to the summer sprays recommended above.

BRAMBLES

A number of troublesome insects and diseases are commonly encountered in growing blackberries, dewberries, and raspberries. Certain diseases, such as *crown gall, orange rust, mosaic, leaf curl* and *bramble streak,* cannot be controlled by spraying. Do not plant brambles on soil where diseased plants have recently grown. Inspect all nursery stock carefully for evidence of these diseases before planting. If trouble appears, dig up diseased plants with as many roots as possible and burn at once.

Mild mosaic of red raspberries, which is not serious on the reds, becomes virulent on blackcaps. Consequently red and black raspberries should not be planted within 300 feet of each other.

Blackberries growing wild often harbor *orange rust* and are a constant source of infection if near a cultivated patch. Varieties resistant to orange

rust should therefore be planted when possible. Blackberries are frequently infested with *rose scale*. If the infestation is severe, spray in the dormant season with either oil emulsion or lime sulfur.

Anthracnose (gray bark) may be controlled either by the selection of a partially resistant variety, such as the Quillen raspberry, or by spraying.

Delayed dormant spray. This spray is primarily for *anthracnose* but may aid in the control of *red spider* and *rose scale* when present. Apply in the spring after the beginning of growth, but not after leaflets have reached ⅜ inch in length. Use oil emulsion and bordeaux, consisting of 2-percent dormant miscible oil or 2½-percent boiled lubricating oil emulsion in an 8-8-100 bordeaux, or use 11 gallons of commercial liquid lime sulfur in 100 gallons of spray, in case rose scale is present, or 6 gallons if absent.

Prebloom spray. This spray which is primarily for *anthracnose* should be applied a week before bloom. Use an 8-8-100 bordeaux to which may be added 1-percent summer oil, or 1 pound of casein lime as a spreading agent.

First post-harvest spray. This spray, primarily for *Septoria leaf spot and anthracnose,* but also important in the control of *red spider,* should be applied immediately after harvest. It should consist of an 8-8-100 bordeaux to which 1-percent summer oil is added.

Second post-harvest spray. Two to three weeks after the first post-harvest spray another bordeaux oil spray, mixed as above, should be applied for *red spider* and *leaf spot* control. Cutting out old fruiting canes before this spray is applied will secure better coverage and save spray material.

Another post-harvest spray may be necessary in some seasons for the control of red spider and Septoria leaf spot on red raspberries in southern Illinois. This should be applied in early September and should consist of the same materials as were used in the first post-harvest spray.

The larvae of certain *sawflies* which work on blackberry and raspberry foliage are controlled by lead arsenate (2 pounds in 100 gallons of spray) applied within a week after the plants are in full foliage.

Sanitary measures such as the prompt removal and burning of the old fruiting canes immediately after harvest, the removal of old stubs of black raspberries in setting a new bed, and clean cultivation are very important in the control of diseases and insects of brambles.

CURRANTS AND GOOSEBERRIES

Currants and gooseberries are largely subject to the same diseases and insect enemies, and hence demand much the same treatment.

San Jose scale may be controlled by a dormant spray of 12 gallons of commercial liquid lime sulfur (testing 33° Baumé) to 100 gallons of solution, or with oil emulsions or miscible oils at the same dilution as for apples.

The *currant worm* may be controlled by spraying with 8 pounds ground derris or cube (containing .75 percent rotenone) in 100 gallons of water. Do not wait until the worms appear but spray early in the season just after the plants come into full foliage.

Spraying for the *currant aphis,* which may be necessary only on cur-

rants, should begin when the leaves are one-fourth open, at which time the eggs are hatching. Apply nicotine sulfate, 2 pints, with 3 pounds potash fish-oil soap in 100 gallons of spray, to the undersides of the leaves. Make second application in 10 days.

Spraying for *currant leaf spot* should be begun when the leaves are unfolding and repeated at intervals of 2 weeks until four applications have been made. Use standard strength bordeaux (page 19).

Anthracnose, leaf spot, and *mildew* on gooseberries may be controlled by the use of lime sulfur. Make first application when the leaves are unfolding, using lime sulfur, dormant strength (as suggested above for San Jose scale). Make three additional applications at 2-week intervals, using 2 gallons of commercial liquid lime sulfur (testing 33° Baumé) to 100 gallons of solution.

GRAPES

Some grape varieties become heavily infested with *scale.* When this occurs, a dormant spray of lime sulfur should be applied as recommended for San Jose scale on currants and gooseberries. *Anthracnose* also may be controlled in part by this same dormant application. It should be applied if anthracnose has been prevalent in previous years. Lime sulfur will injure the plants if applied while they are in foliage.

The grape flea beetle, if troublesome, will appear as the buds are swelling. The opening buds should be protected with an application of 4 pounds lead arsenate in 100 gallons of spray.

Common grape troubles can usually be held in check by the following spray schedule:

First application. For *grape berry moth, rose chafer, black rot,* and *anthracnose,* apply just before bloom a combination of bordeaux standard strength (page 19) and 3 pounds lead arsenate in 100 gallons of solution.

Second application. Use same mixture as for the first application. Apply immediately after the bloom has fallen. This is for control of *grape berry moth, leaf folder,* and occasionally *grape root worm* and *rose chafer,* as well as for *black rot, anthracnose,* and *downy mildew.*

Third application. This is made 10 days after fall of bloom, for the control of *grape root worm, leaf folder, rose chafer,* if present, *black rot, anthracnose, downy mildew,* and *powdery mildew.* Use combination spray of bordeaux with 2 pounds calcium arsenate in 100 gallons of spray. Calcium arsenate is substituted for lead arsenate in this application in order to avoid illegal spray residue.

Fourth application. Make 3 weeks after bloom has fallen, for the control of *grape root worm, black rot, anthracnose, ripe rot,* and the *mildews.* Use same mixture as for third application but omit calcium arsenate; where leafhoppers are present add nicotine sulfate (1 pint in 100 gallons of solution). Apply spray thoroly, especially to undersides of leaves. The insects should be hit by the spray.

STRAWBERRIES

Most insect pests and fungous diseases of strawberries can be controlled by proper cultural methods. An infestation of *white grubs,* the larvae of

the May beetle, or "June bug," can usually be avoided by not planting on sod land.

Where *leaf spot* is troublesome, control by spraying with bordeaux (4-6-100). Make first application before blossoming, and second just after blossoming.

Where the *leaf roller* is destructive, lead arsenate (3 pounds in 100 gallons of spray) applied at the first appearance of blossoms, is effective. Spraying should be done before the worm has protected itself by folding up the leaf. A pressure of at least 100 pounds helps materially to drive the solution into the folds where insects may have begun their attack. Do not apply lead arsenate after the berries have formed.

A combined spray of bordeaux and lead arsenate applied before and after blossoming and again as soon as new foliage appears after the patch has been renovated in late summer, will aid in controlling *leaf spot, leaf* roller, and other insects such as the *flea beetle.*

Mowing and burning over the bed, followed by the narrowing down of the rows, an operation in the renovating process, also are a great help in holding strawberry pests in check.

PART III—PREPARING AND MIXING SPRAY MATERIALS

Materials for the preparation of sprays and dusts should be selected only after careful consideration of their merits, as determined by experimental evidence. Home preparations are usually cheaper than commercial products, but it is often more convenient to use standard commercially prepared materials. Directions are given below for the preparation and mixing of certain homemade standard sprays and dusts. This is followed by a description of some of the types of commercially prepared materials which are in general use.

BOILED LUBRICATING OIL EMULSION

To make the stock emulsion of boiled lubricating oil use:

Light-grade lubricating oil[1].....1 gallon
Water.....1 quart
Potash fish-oil soap (40 percent soap).....1 to 2 pounds
(Many waters require more than 1 pound of soap to stabilize the emulsion.)

Place water, soap, and oil in a kettle or tank heated by fire or steam. Boil for 5 minutes, being careful not to burn the mixture; remove from fire or turn off steam and pump thru a spray pump at 150 to 250 pounds pressure. At the higher pressure, one pumping is usually sufficient.

To make the stock emulsion on a large scale, use an all metal pump. The rotary type is very satisfactory. For small amounts a barrel pump may be used. The stock emulsion should not be made in a cooker pre-

[1]Best results have been obtained with oils within the following specifications:
Specific gravity at 20° C.....0.87 to 0.93
Volatility at 110° C. for 4 hours.....not above 10 percent
Viscosity at 100° F.....90 to 250 seconds (Saybold test)

viously used for cooking lime sulfur without a thoro cleaning, nor should it be stored in lime-sulfur barrels.

Use precaution to prevent the stock emulsion from freezing. If it does freeze, allow it to thaw out gradually and apparently no harm results. Do not heat or stir while thawing. A common method of testing doubtful stock emulsion is to put about a half pint into a bucket of water. If the diluted material has a milky appearance with no free oil on top, the emulsion has not broken down. When stock emulsion has stood for some time, a part of the soap may settle to the bottom of the container in a dark brown layer. This does not injure the emulsion, but the material should be stirred well into the emulsion before diluting for spraying.

Directions for diluting the stock solution for spraying are given in the spray schedules for apples and peaches. In diluting, if the oil separates, it is advisable to fill the tank with ½-1-100 bordeaux and then to add the required amount of stock emulsion.

Spray tanks which have been used for lime-sulfur solution must not be used for oil emulsion until they have been washed out with bordeaux mixture. To wash a tank with bordeaux, 8 pounds of hydrated lime or 6 pounds of freshly slaked lump lime should be mixed with about 100 gallons of water in the tank, and a solution containing 4 pounds of copper sulfate should be poured in while the agitator is running. When the inside of the tank has been thoroly splashed and soaked with the solution, a few gallons should be run thru the pump and hose and the tank drained.

Some cold mixed oil emulsions have given good results in scale control and are the cheapest sprays that can be used for this purpose (see directions for making cold mixed emulsions below).

Boiled lubricating oil emulsion plus bordeaux. Make an 8-8-100 bordeaux mixture (see directions for mixing bordeaux) and add the required amount of boiled lubricating oil emulsion (see above) with agitator running.

COLD-MIXED OIL EMULSIONS

Bordeaux cold-mixed. Pump together equal parts of oil and 8-8-100 bordeaux mixture, sending the material at least twice thru the pump. For a 2-percent strength, dilute 4 gallons in 100.

Calcium caseinate cold-mixed. Pump together 2 gallons of oil and 1 gallon of water in which is dissolved 4 ounces of calcium caseinate. For a 2-percent strength, use 3 gallons in 100. These emulsions should be used at once since they separate on standing.

BORDEAUX

When a small quantity of bordeaux is needed, a commercial preparation may be used. Dilute according to the directions of the manufacturer. For a considerable amount of spraying, bordeaux is ordinarily prepared by the orchardist according to the following "standard" formula:

4 pounds copper sulfate (blue vitriol)
6 pounds hydrated lime
—or 4 pounds lump (stone) lime
100 gallons water

Copper sulfate (blue vitriol, blue stone) is sold in three forms, large granules, small granules ("Snow"), and powdered. "Snow" and powdered forms are used almost exclusively by growers on account of their convenience in mixing. These forms must be kept in closed containers to prevent rapid deterioration. When large crystals are used, it is necessary to begin dissolving several hours before the spraying is to start. In ordering, the form of copper sulfate crystals desired should be indicated.

Lime for spraying is in two forms, hydrated and unslaked. Unslaked lime may be purchased as "lump" or stone lime, or in a pulverized form in closed containers. Most growers now use the hydrated form. Lime should be purchased near the time when it is to be used and should not be kept from one season to another. Hydrated lime should be bought when possible from firms manufacturing a special "spray" lime.

Directions for mixing "instant" bordeaux. Where large quantities of bordeaux are to be made and used at once, a rapid, convenient method of mixing is as follows: Fill tank about one-fourth full of water; with agitator running, sift in slowly the required amount of snow or powdered copper sulfate, and continue filling the tank. When the tank is about two-thirds full, add required amount of lime in the form of a thin paste and finish filling the tank.

Old process. When bordeaux is made by the old process or when small quantities are required, mixing may be done as follows: If stone lime is used, prepare two stock solutions, one of lime and one of copper sulfate, using these materials at the rate of 1 pound in a gallon of solution.

Carefully slake the lime with just enough water to prevent the formation of a dry powder. After the violent boiling is over, add a small amount of water. Work to a paste or cream and let cool; then dilute to contain 1 pound of lime to a gallon of solution.

If hydrated lime is used, the amount required for each sprayerful should be stirred into enough water to make a thin paste.

Place required amount of copper sulfate in a cloth bag and suspend in a wooden or stone vessel just at the surface of the water which has been measured into it. Do not stir until copper sulfate has dissolved.

The copper sulfate and lime are now ready for mixing. First, with the agitator going, partly fill the sprayer with water. Then add the required amount of copper sulfate stock solution. If the above "standard" formula is used, it would require 4 gallons of the stock solution to each 100 gallons of water. Continue filling the tank until it is two-thirds full. Next add the lime water—4 gallons of the stock solution if stone lime is used or 6 pounds of hydrated lime. Then add water to make up the final volume.

Oil emulsion plus bordeaux. To an 8-8-100 bordeaux add 3 gallons of boiled lubricating oil emulsion for each 100 gallons of spray.

Field preparation of cold-mixed oil emulsion and bordeaux. In one container (a barrel is convenient) dissolve copper sulfate at the rate of 1 pound to 2 gallons of water. In another container mix hydrated lime in the same proportions. To make 100 gallons pour 4 gallons from each container simultaneously into the tank with the agitator running. Add 1½ to 2 gallons of oil (for proper specifications see footnote on page 18),

and run the pump so that the mixture is pumped back into the spray tank for a few minutes. This is the cold-mixed oil emulsion. While the tank is being filled with water, add 6 pounds copper sulfate (previously dissolved) and 6 pounds lime, as lime water, for each 100 gallons of complete spray. Use the mixture at once, for the oil may separate on standing.

ZINC SULFATE AND LIME

The formula now recommended for zinc sulfate and lime is:

6 pounds zinc sulfate
6 pounds hydrated lime
100 gallons water

Directions for mixing. Commercial zinc sulfate may be used. Run into the tank a few gallons of water and then add the required amount of zinc sulfate. Continue filling the tank. The zinc sulfate dissolves rapidly and will be in solution by the time the tank is two-thirds full. Add, thru the strainer, the required amount of lime, which has previously been made into a thin paste in a separate container. Finish filling the tank and agitate a few minutes before spraying.

OTHER SPRAYS

Directions for making wettable sulfur. Sulfur of at least 300-mesh fineness should be purchased from some reliable company. This is made wettable by adding it to a solution of lignin pitch which is a by-product of the paper manufacturing industry. The powdered form of lignin pitch is more convenient than the liquid. It is sold under the trade names of Goulac and Bindarene Flour.

First make a 2-percent solution of the powdered lignin pitch. This is at the rate of 4 pounds to 25 gallons of water. The mixing of the sulfur with this 2-percent solution can be done most conveniently in half barrels or tubs. To 12½ gallons of the lignin pitch solution add 200 pounds of sulfur. A good method of mixing is to have about 5 gallons of the liquid in the tub and add the sulfur, stirring it in (the more vigorously the better) until a thick paste is formed, but not too thick to stir well. Then add the remainder of the liquid and stir thoroly. Allow to stand for an hour or so and then stir again. At this time it will be found that a number of small lumps are formed in the scum and on top of the finer sulfur which has settled to the bottom. These pellets may be broken up by pouring the mixture thru a coarse screen (8 to 10 mesh) and rubbing the sulfur lumps with the hand. Use some of the liquid to wash the sulfur thru the screen.

Leave the mixture in the tubs for 12 to 24 hours and then pour off the liquid above the settled sulfur. This liquid may be used again since it does not lose strength. Disregard the small amount of sulfur poured over with this solution.

Scoop out the paste formed in the bottom of the tubs and store in a covered barrel to prevent rapid drying out. If the sulfur paste is to be kept over a period of several weeks, a gallon or two of the lignin pitch solution may be poured over the top of the sulfur. Drying does not affect the wetting properties of the sulfur. The sulfur paste is now ready to use and may be mixed in the same manner as any of the commercial wettable

sulfurs. The paste contains about 33-percent water. To determine the amount to use multiply the amount required in dry sulfur by 1.5. For example, if 6 pounds of dry sulfur are required, it will take $1.5 \times 6 = 9$ pounds of the sulfur paste.

It should be understood that this homemade wettable sulfur is not superior to the commercial wettable sulfurs and should not be substituted for lime sulfur in the control of apple scab. It is inferior to these sulfurs because it requires considerable care in its manufacture and is less convenient to handle. Since the commercial wettable sulfurs may be bought at a reasonable price, the grower with a small acreage is not advised to make his own wettable sulfur.

Since the sulfur paste contains no lime it is necessary to add the required amount of lime when lead arsenate is used.

Dry-mix sulfur-lime. The formula for a dry-mix sulfur-lime is as follows, the percentages being based on weight:

64 percent superfine (dusting) sulfur
32 percent hydrated lime
4 percent casein-lime

To remove lumps, first work the sulfur thru a screen having 12 to 14 meshes to the inch. Then thoroly mix all the ingredients. This product may be stored indefinitely in a dry place. For spraying, use 12½ pounds of dry-mix in 100 gallons of water. Add lead arsenate for the control of certain insects.

Lead arsenate. If thoro agitation is not possible, lead arsenate should be made into a thin paste before it is strained into the sprayer. If it is not used in combination with bordeaux, zinc sulfate and lime, or liquid lime sulfur, 1 pound hydrated lime should be used with each pound of lead arsenate as there is always a small amount of soluble arsenic present, which may be injurious to the foliage unless neutralized by the lime.

Bordeaux and lead arsenate. It is usually advantageous to combat insects with the same application used against fungous diseases. If bordeaux is to be used, the required amount of lead arsenate can be added after the bordeaux is completed.

Lime. Injury to peaches and to a lesser extent to apples frequently occurs if lime is not used with lead arsenate, according to experimental work carried out over a period of years by the Illinois Station and the Illinois State Natural History Survey. The lime may be in the spray mixture in the fungicide, as in lime sulfur (*not* flotation sulfur) or in bordeaux mixture, but when not present in the fungicide, hydrated lime should be added at the rate of 1 pound to each pound of lead arsenate.

Lime aids in the removal of spray residue by weathering; also in the removal of spray residue by acid washing solutions.

Lime sulfur and lead arsenate. When using lime sulfur and lead arsenate in combinations, first place the lime sulfur in the sprayer and fill to about two-thirds capacity with water. Then, with the agitator on the pump working, strain the lead arsenate into the sprayer and add enough water to complete the volume desired.

Nicotine sulfate. This material may be purchased in concentrated form. One gallon will make 800 to 2,000 gallons of spray mixture. If used

alone, add enough fish-oil soap or laundry soap to soften the water, i.e., to make it sudsy when stirred; this usually requires at least 2 pounds of soap to 50 gallons of water.

The most common brand of nicotine sulfate is "Blackleaf 40." The same manufacturer has another brand known as "Blackleaf 50." This is a form of free nicotine and does not require the addition of soap to the spray solution. It contains 10 percent more actual nicotine than "Blackleaf 40."

Nicotine sulfate may be used at 1-2000 with the better class of commercial miscible oil sprays, or with homemade lubricating oil emulsion. This makes a very effective combination against aphids.

Homemade lime sulfurs. Directions for making homemade lime sulfur will be furnished on request to the Agricultural Experiment Station, Urbana, Illinois.

OIL DUSTS

One of the best dusts for use on peaches for the control of curculio is made by thoroly mixing the following ingredients:

60 pounds dusting sulfur
25 pounds dusting lime
10 pounds lead arsenate
5 pounds light grade lubricating oil of 80 to 100 viscosity.

For dust for Oriental fruit moth control during the period three weeks before harvest, omit the lead arsenate, using the following formula:

60 pounds dusting sulfur
35 pounds dusting lime
5 pounds lubricating oil of 80 to 110 viscosity.

There is a slight improvement in the dust if 300-mesh talc is used in place of half the lime in either formula. The ingredients must be thoroly mixed in a dust mixer. Simply stirring the materials together will not make a satisfactory oil dust.

PART IV—COMMERCIAL PREPARATIONS

Commercial liquid lime sulfur. Most growers now purchase liquid lime sulfur from reliable companies. This is prepared in large quantities and is standardized so that the quality is fairly uniform. The grower should consider mainly the price at the orchard and the service given by the company. While specific gravity or Baumé reading is usually an indication of the concentration of fungicidal sulfur, this may vary. However, it is the only simple method of determining the fungicidal sulfur content of lime sulfur.

Dry lime sulfur. Lime sulfur can be dehydrated and prepared as a dry powder. While more expensive than liquid lime sulfur, it is much more convenient to handle, and the waste is not so great.

Wettable ground sulfurs. Pure sulfur, however finely ground, is not wettable; the addition of certain wetting agents is necessary before it can be used in liquid sprays. A number of commercial brands of wettable sulfurs are now on the market. They have the advantage over dry-mix sulfur-lime in that, owing to the absence of lime, they do not mar the

appearance of the fruit. In purchasing wettable sulfurs, the grower should consider five points: (1) *percentage of sulfur;* (2) *price;* (3) *fineness of particles;* (4) *rate of settling;* (5) *convenience of mixing.*

A material having less total sulfur is not necessarily inferior provided the price is correspondingly low and the recommendations call for equivalent amounts of sulfur. The ground wettable sulfurs are not so toxic to fungi as is lime sulfur but they are safer to use on plants subject to lime-sulfur injury.

Flotation sulfur. Sulfurs recovered from artificial gas plants by a process of precipitation and flotation are grouped under the general term of "flotation" sulfurs. They are sold in three forms: *paste, dry wettable,* and *dust.* The paste form contains about 40 percent sulfur and this should be taken into consideration in mixing.

Owing to the method of production, the sulfur particles are extremely fine and consequently possess greater fungicidal power than the ground sulfurs. Like the ground wettable sulfurs, flotation sulfur is less injurious to plants than is lime sulfur.

Summer oil emulsions. Summer oil emulsions are made from highly refined white oils emulsified with certain types of emulsifying agents. There are several reliable brands now on the market; these must be used according to the manufacturer's directions.

Miscible (soluble) oils. There are on the market oils known as miscible or soluble oils. Oils of this type are concentrated emulsions containing little water and they therefore are resistant to freezing. They consist of a mineral oil base combined with an emulsifier in such a way that the resulting mixture is a clear fluid, in the undiluted form possessing the appearance of a clear oil. When water is added to miscible oils, a typical white emulsion is formed.

The ingredients of various miscible oils vary greatly, and consequently the various products may differ widely in their ability to emulsify with water, in their stability, keeping quality, and in their insecticidal and other properties. Miscible oils must be applied according to the manufacturer's recommendations. The grower can mix these oils, but the process requires special care, and in most cases home-mixing is not advisable.

Tar washes. These are commercially prepared miscible tar oils and should be used at the strength recommended by the manufacturers. They are very effective for dormant control of aphids.

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3-35—10,000—7253
5-35— 5,000—7688